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Abstract

As cities are rapidly developing new interventions against climate change, embedding renewable energy in public spaces is an important strategy. However, most interventions primarily include environmental sustainability, while neglecting the social and economic interrelationships of electricity production. Although there is a growing interest in sustainability within environmental design and landscape architecture, public spaces are still awaiting viable energy-conscious design and assessment interventions. The purpose of this paper is to investigate this issue in a renowned public space—Ballast Point Park in Sydney—using a triple bottom line (TBL) case study approach. The emerging factors and relationships of each component of TBL, within the context of public open space, are identified and discussed. With specific focus on renewable energy distribution in and around Ballast Point Park, the paper concludes with a general design framework, which conceptualizes an optimal distribution of onsite electricity produced from renewable sources embedded in public open spaces.

Keywords

Ballast Point Park / public space / renewable energy distribution / sustainability / triple bottom line (TBL)

Introduction

Cities around the world are grappling with growing energy demands. As of 2009, cities consumed 60 to 80 percent of energy with expectations that the general global demand for energy would increase by 45 percent over the next fifteen years (*Kamal-Chaoui and Robert 2009: 17*). The transition to sustainable energy resources is found as a long-term solution to this problem, yet it requires a deep societal shift in order to sufficiently address the situation. Evidence of this shift is the increased use of energy from renewable sources in cities around the globe (*Droege 2009: 45*). While renewable energy is becoming widespread, cities are adapting new policies to promote local clean energy. Energy independent cities and neighbourhoods are emerging. Concepts like distributed energy neighbourhoods, virtual renewable energy utilities, and resilient micro and smart grids indicate a transition to new energy urban environments (*Droege 2009*). These fast changing urban environments require new spatial and aesthetic qualities, often included in landscape architecture and environmental design research. However, thus far, such research has focused primarily on energy-conscious design (*Stremke and Koh 2010*) from a planning scale, neglecting urban micro scales. Yet, moving forward, Byrne et al, (*2009: 88*) suggest locating 'energy-ecology-society relations in a commons [1] space […] focusing on techniques and social arrangements which can serve the aims of sustainability and equity'.

Public open space can serve as this commons space, potentially contributing to the necessary societal shift that includes acceptance and understanding of renewable energy. Scholars have suggested that 'New public space designs need to arouse desire in the public to participate, to cultivate and to advocate' (*Amidon 2009: 178*). In addition, current landscape architecture theory promotes a dynamic approach to public open spaces concerned with programs, infrastructure, network flows, and multifunctional and flexible services (*Wall 1999: 234*). For example, a public park is a non-profit asset for a community. If economic production occurs within a park, such as producing electricity from renewable energy sources, it may be possible to use the revenue for direct community benefit and subsidize park maintenance costs (*Garvin and Brands 2011: 205*). Yet, implementing these ideas into public spaces can be challenging for landscape architects and, so far, the social and economic components of sustainable energy usage have not been fully explored in a public space context.

To operationalize and implement sustainability into practice, many sub-definitions and frameworks have emerged over time. One of them is 'triple bottom line' (TBL), which originated in the 1990s as a tool to integrate sustainability into the business world by minimizing the detrimental impact of economic activities of corporations on society and the environment (*Elkington 1998; McDonough and Braungart 2002: 252*). The three components of the TBL are intertwined and are often referred to as environmental quality, economic prosperity, and social justice (*McKenzie 2004: 6*). More specifically, and for the purposes of this paper, we focus on the following objectives of each component [Fig. 1]:

- Economic Sustainability: efficient use of limited resources; ethical production of goods and services (*Assefa and Frostell 2007; Baumgärtner and Quaas 2010*).
- Social Sustainability: equitable access and use; social cohesion; social acceptance of green innovation (*Assefa and Frostell 2007; McKenzie 2004; Rogers et al. 2012*).
- Environmental Sustainability: renewable energy usage as part of development, sustained global life support systems; requiring economic and social sustainability (*Dincer 2000; Goodland 1995; Rostami et al. 2014*).

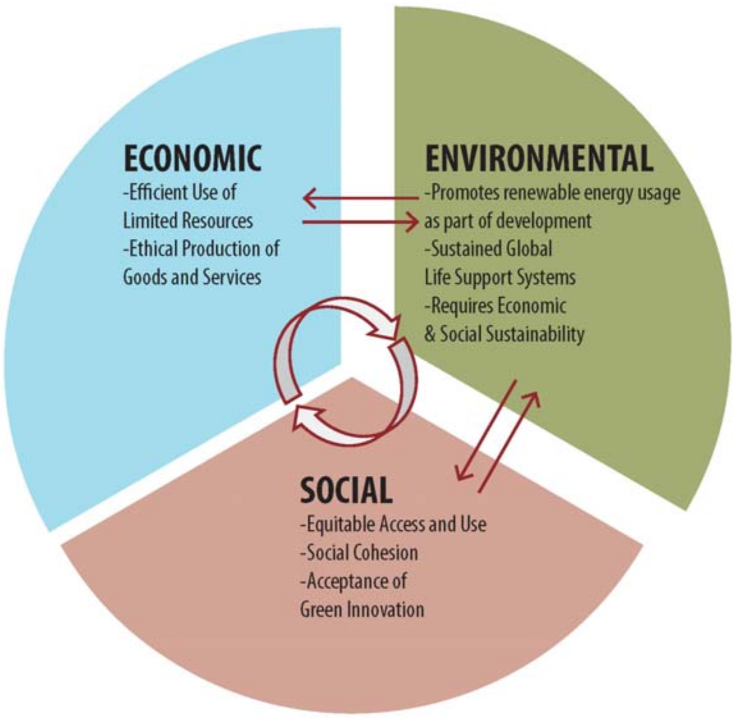

Figure 1 Research Driven Triple Bottom Line Objectives

Since the three components of TBL are intertwined, we have focused on TBL in its entirety as a framework for design. The TBL framework is recognized and supported by the Australian Institute of Landscape Architects (AILA) (*AILA 2010a*), which contends that it raises the potential for new ways of analyzing, designing, and managing sites across a wide range of scales. While there is currently no accepted assessment tool for public spaces in Australia that uses the TBL framework, the Sustainable Sites Initiative (SITES) (*2009: 6*) has created a tool with 'guidelines and performance benchmarks for sustainable design, construction and maintenance in landscape architecture projects'. This framework has been tested using many case studies in the United States, and in recent years, AILA tested the framework in Australia. Similar to the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) rating system for architecture, the SITES rating system uses a point system to assess projects based on a set of criteria that are predominantly environment driven. However, this quantitative assessment approach can leave the social and economic aspects of sustainability, and specifically renewable energy use in public space, vague and undervalued.

Therefore, the purpose of this paper is to address the sustainability assessment of built public space designs using a TBL approach. This paper analyzes the three components of TBL within an award-winning public space, Ballast Point Park in Sydney, New South Wales and focuses on how designers and experts approach renewable energy. Using this park as a case study, this paper explores TBL as a framework for design. The paper identifies and reflects on the emerging factors and relationships of each component of TBL, specifically focusing on renewable energy. The paper concludes with recommendations for a potential design framework to sustainably distribute electricity produced from renewable sources in public spaces.

Research on design: case study method

To more fully understand TBL within the context of public open space design, we employed a case study method within a 'research on design' methodology. The research on design approach focuses particularly on built projects or design processes using post occupancy evaluations, plan analyses and case studies (*Deming and Swaffield 2011; Lenzholzer et al.*

2013: 121). Ballast Point Park was explored as an ‘instrumental case’ to develop insight into an issue, focusing on an embedded topic, renewable energy usage in public spaces (*Silverman 2013: 142*). Next, we describe the Ballast Point Park context.

Case study site: Ballast Point Park

We chose Ballast Point Park, a 2.6 ha park, located in Birchgrove on the Balmain Peninsula in Sydney Harbour [Fig. 2].

Figure 2 Ballast Point Park and its location within Sydney Harbour Context.

The park is the first landscape architecture project recognised by AILA for electricity production:

‘The design uses world-leading sustainability principles to minimise the project’s carbon footprint and ecologically rehabilitate the site. The design reconciles the layers of history with forward-looking new technologies to create “a regionally significant urban park”. The environmental approach is further underpinned by site-wide storm water bio filtration, recycled materials, and "wind turbines for on-site energy production"' (emphasis added by authors [*AILA 2010b*]).

Ballast Point Park has received numerous awards for its intelligent, respectful, and educational design scheme. AILA (*2010b*) specifically recognized the park's 'design excellence and functional quality; clarity and legibility of expression of design concept; sensitivity to social, cultural, historical, physical and natural context; and relevance to the profession of landscape architects, the public and the education of future practitioners', among other aspects. Similarly, Wallis (*2012: 12*) compares Ballast Point Park to the renowned Barangaroo development in East Darling Harbour, stating, 'This internationally acclaimed design, which surpasses the sustainability claims of Barangaroo, features the revitalization of a polluted former industrial tank site, the reuse of soil and water, "energy production", the use of indigenous plants and the promotion of biodiversity' (emphasis added by authors). Using Ballast Point Park as an instrumental case, we deconstruct the TBL framework to examine how designers and other experts address each TBL component and specifically focus on renewable energy. To do this, we employed a multiple method approach described below.

Methods of data collection

Semi-structured interviews

To understand Ballast Point Park as the context for renewable energy usage, we interviewed designers and other experts involved in the project. [2] In total, we conducted semi-structured interviews with five people in person and via Skype, including three landscape architects from the lead design and planning firm, one project manager, and one consultant involved in the design, planning and community consultation process. All interviews lasted one to two hours, and focused on the following key topics:

- The general philosophy of sustainability, TBL, and renewable energy;
- How renewable energy was incorporated into the park design;
- Original goals for the project (social, ecological, economic, aesthetic, etc);
- Perceived social impact of the project and public reaction;
- The dynamics of the project team (multi-disciplinary); and

- The community consultation process.

We used NVivo software to thematically code the interview transcripts using the components of TBL as the guiding structure. We then compared these findings with data collected through the site observations and user survey described below.

Site observation and user survey

We conducted site observations that involved discreetly recording user behaviour throughout two weeks in January 2014, during summer in the southern hemisphere. Selected times included weekends, weekdays, and a public holiday with rotating shifts of early morning 7:30–10:00 am; morning 10:00 am–12:00 pm; mid-day 12:00 pm–2:00 pm, early afternoon 2 pm–4 pm; and late afternoon 4 pm–7 pm. We recorded details of the activities and users on a spreadsheet and site map. The site was divided into six observation zones and we moved between zones every twenty minutes to record the site usage. An anemometer was used to measure wind speed and direction, temperature, humidity, and sunlight levels and uploaded all raw data into Arc GIS to determine patterns.

In addition, during the site observation process, we approached thirty-four random park users at different time periods and asked two questions: 1) Do you live in the area?; and 2) Do you realize that this park has the capacity to produce electricity from a renewable source? We analyzed responses to determine whether users were predominately local or regional users and whether they were knowledgeable about the electricity production from renewables designed into the park.

Findings

Based on our data analysis, and a review of previous literature, we identified several design parameters that indicate landscape architects' alignment with TBL during the design process and compared these parameters with the TBL objectives described earlier. Our parameters include physical features, activities, accessibility, design and interpretation, and process components. Many of these parameters have multiple implications and could be viewed from different perspectives. One example of how these parameters can be evaluated using the TBL objectives can be seen below [Fig. 3].

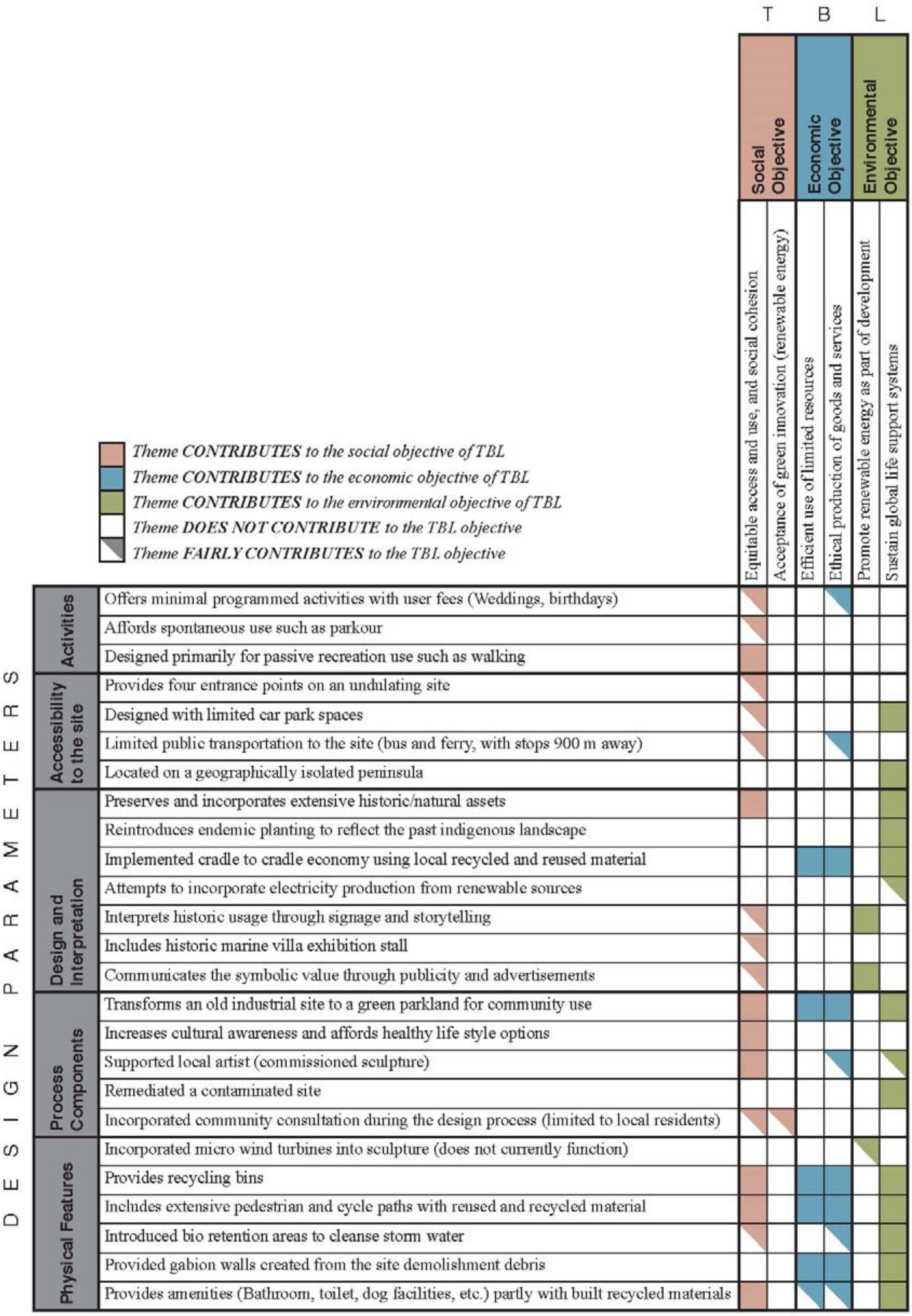

Figure 3 Ballast Point Park indicative design assessment based on research driven TBL objectives

Based specifically on our data, we determined if the parameter contributes to the specific TBL objective, the box is fully coloured. If the parameter does not contribute to the TBL objective, the box is left empty. If the parameter fairly contributes to the TBL objective, the box is left half-full. For example, under the process components, the park transforms an old industrial site to a green parkland for community use. This parameter contributes well to the equitable access and use, and social cohesion under the social objective of TBL. Transforming an old industrial site also contributes fully to the efficient use of limited resources, as well as ethical production of services within environmental objective. Lastly, a transformation like this contributes highly to the environmental objective.

We found that environmental sustainability was a key driver for the innovative design of Ballast Point Park. The park, as stated by AILA and other scholars, successfully accomplishes many accepted environmental sustainability objectives including, but not limited to, increasing biodiversity and cleansing air and storm water. Similarly, the intention to incorporate renewable energy as an innovative approach to environmental sustainability was also well-received by the design community and the public.

In summary, the design parameters of the park contributed primarily to the environmental objectives while contributing less to the social and economic. Later in this section, we describe these in detail.

Economic

Through our analysis of economic sustainability ('efficient use of limited resources', and 'ethical production of goods and services'), we determined that the Ballast Point Park design exhibits limited economic sustainability due to its high cost as a local park against less efficient sustainable service and goods production. And although cradle-to-cradle economy was desired for the park, some environmental practices are only partially successful due to the discrepancy between intention and the reality of the current situation. Specifically:

- Costing AU$ 25 million, the park is a state-funded asset that was designed as a regional park to also accommodate a maritime refilling facility. However, it currently functions primarily as a neighbourhood park in the affluent Birchgrove suburb.

- Currently there are only a few programmed activities, such as wedding ceremonies, that require user fees to help meet maintenance costs.
- The wind energy generator installed in the park currently does not function and, therefore, does not supply electricity to the park for daily use and to reduce the costs of maintaining the park.

Ballast Point Park is a state asset funded primarily to maintain its regional heritage quality. As discussed by O'Neill, the total project cost approximately AU$ 25 million, including land acquisition, site remediation, planning, design, and construction. In addition, O'Neill (*2014*) argues, 'It has been designed to be a park of regional significance. The value in terms of its basic environmental value is not that it provides a 2.5 ha park to a local area. I think if that was the only value that Ballast Point offered, it would never have been acquired and it would never have been turned into a park. It would be covered in residences right now. What made it significant was the position that 2.5 ha occupied on Sydney Harbour. It was about the significance of being able to provide, or re-establish, a green headland where Ballast Point is, opposite Balls Head and Milsons Point, Bradleys Head, Blues Head, Blues Point and Goat Island and soon the headland of Barangaroo. It was about this.'

The park size and observed overall usage indicates that the park is currently a local park. The open space document for New South Wales recommends that a local park should be between 0.5 to 2 ha, while a district park is between 2 to 5 ha, and a regional park is more than 5ha (*SGS Economics & Planning 2010)*. Therefore, at 2.5 ha, Ballast Point Park sits at the lower end of the district park category.

Despite the predominately local use, the initial funding amount aligns with the regional significance of the headland park. Although initially part of the master plan, but later excluded from the design and never completed, the maritime refilling facility influenced why the park received initial state funding. O'Neill (*2014*) explains that many people do not realize that the state ownership was partly about 'making sure the government could retain a place on Sydney Harbour where it could refill ferries from a state-owned filling facility.' This regional use was imperative for the project at the beginning, yet the community consultation process led to design decisions based primarily on local views, rather than regional input, which significantly impacted the park's regional use.

According to O’Neill (*2014*) ‘Community consultation […] over the past ten years has been an evolving science. When we started in Ballast Point, it was reasonably new. In some ways I think Ballast Point went out to community a little bit too blue sky’. He contends that a lack of experience in consultation led to asking for community input prematurely, rather than going to the community with two or three carefully determined scenarios based on research and site assessment (*O'Neill 2014*).

The community consultation process also led to the choice of wind power in the park. A group of community members expressed a desire to keep the post-industrial remnants in the park, including the Tank 101 in which the wind turbines were integrated [Fig. 4].

Figure 4 Renewable Energy Sculpture: Micro wind turbines integrated into the structure built with recycled material from the former Tank101 once was standing at the same location

Although the design inspiration for wind turbines and wind power is ingrained in the stories of the community, from an economic perspective, the initial intent of producing electricity on site was to balance out the operation demands of the park (*Kennedy 2014;*

McDermott 2014). However, the wind turbines in the park are currently dysfunctional and do not produce electricity for the site. In addition, people that we talked with during our site visit, including a maintenance gardener, had only observed the turbines rotating once or twice during the last five years.

The interviewees indicated that the team lacked sufficient time, expertise, and experience for assessing the design and application of the renewable energy (*Coxall 2014; Kennedy 2014; McDermott 2014*). The entire technology was new and with newness came risks. In order for the turbines to work efficiently, an inverter was needed and both its presence and cost was not planned initially. In the end, it was the inverter that caused the majority of the issues (*Coxall 2014*).

Despite this limitation, the intent to produce electricity from renewable energy on site and reuse a historical structure aligns with objectives of environmental and economic sustainability. The notion of reusing and recycling is extended to the 'cradle to cradle economy', which the designers persistently, and often quite successfully, tried to implement in Ballast Point Park. Site materials from the demolition, including site soil, mulch material, aggregates and bricks, sand stone boulders, crushed concrete, existing structures such as stairs, pathways, foundations, bund walls, and old rusted tanks, were reused and incorporated into the design. However, the principle designer also discussed the discrepancy between their genuine intention and the reality of the political system that did not enable some environmental practices to be fully realized. Technical, methodological, and logistical constraints were common. For example, the broken bricks from old structures were to be processed and used on site. However, the designer states, 'It worked out that it was more expensive to process the debris on the site, than take it to the processor and get it back to the site' (*Coxall 2014*).

The limitations in economic sustainability also have an impact on the social component of TBL. We discuss this in the next section.

Social

The level of social sustainability in the park is mixed. As a popular, well-designed, multi-use space, Ballast Point Park improves the quality of life for the neighbourhood residents and has become a well-used gathering spot that promotes community connectedness and social cohesion. However, using ‘equity’ as a parameter with which we explored social sustainability, our findings show that Ballast Point Park is inaccessible to a large number of regional users.

Through our site observations, we discovered several characteristics that limited equitable access to the park, and thus social sustainability, including: a lack of public transportation to the site via bus and ferry, the geographic location of the park as a somewhat isolated peninsula, a lack of commercial programming that feeds regional and local use such as a café and gift shop, and a lack of sufficient car parking spaces for people travelling from significant distances. These limiting characteristics were reiterated by the interviewees (*Coxall 2014; James 2014; O'Neill 2014*).

Two interviewees discussed ideas to increase the regional use of Ballast Point Park, such as the addition of a ferry terminal and ferry tour that could take tourists around all of the key parks in Sydney (*Coxall 2014*). Similarly, another interviewee (*O'Neill 2014*) suggested that Sydney Harbour Foreshore Authority (SHFA) could organize events within various sites under their management, including the Rocks, Darling Harbour and Cockatoo Island, to attract people from a wider area of Sydney and increase the regional use of Ballast Point Park. However, these ideas have yet to be realised.

As a multi-use public space, Ballast Point Park affords activities such as sitting, walking, running, exercising, dog walking, cycling, skate-boarding, kayaking, and pushing a pram during the week, in addition to fishing, barbeques, and picnics on public holidays and weekends [Fig. 5]. The frequency of each activity, and its occurrence on a weekday, weekend, and public holiday, as well the occupancy of car park spaces, helped us to define regional and local activities.

ACTIVITIES	NOT OBSERVED	REGIONAL	LOCAL
Passive recreation use			
Barbeque		■	
Walking			■
Dog walking			■
Walking a child			■
Exercising + yoga			■
Running			■
Sitting			■
Cycling			■
Skate-boarding			■
Soccer		■	■
Sketching			■
Lying on grass		■	■
Pushing a pram			■
Walking with poles			■
Fishing		■	
Observing the view		■	■
Kayaking			■
Site seeing		■	■
Picnicking		■	
Taking photo		■	
Kite flying		■	■
Frisbee		■	■
Spontaneous use			
Events including wedding photography and birthday celebrations		■	
Vow wall where people put locks on		■	■
Event photography		■	
Parkour	■	■	■
Boules	■	■	■
Geo-cashing		■	■
Programmed activities with user fees			
Cafe shop, gift shop	■		
Wedding ceremonies		■	


Wedding ceremony


Event photography


Geo-cashing


Vow wall


Pushing a pram


Running


Observing the view


Birthday Celebration


Walking


Kayaking


Cycling


Skate-boarding


Dog walking


Site seeing


Fishing


Barbeque

Figure 5 Passive and Programmed Activities and Spontaneous Use

We also observed spontaneous activities like event photography and birthday celebrations, as well as outdoor events such as geo-cashing that occurred on the weekend and public holiday. The park's authentic historical remnants and elegant physical design, along with magnificent harbour views attract couples to have wedding photographs in the park. In particular, the Tank 101 energy sculpture was a prime backdrop for photographs [Figs.5–6–7]. These events indicate regional use, and therefore align with the equitable aspects of social sustainability.

Figure 6 Standing on the Belvedere and looking down to Sydney Harbour on the right and Tank 101 Energy Sculpture on the left

Figure 7 Standing on the verge of Belvedere and looking down to the nose and Tank 101on the right; the main entrance is on the left

The recycled gabions are also used as a 'vow' wall on which people attach locks [Fig. 5]. Kayaking, playing soccer, barbeque, and flying a kite are some other activities occurred on site occasionally [Fig. 5]. In addition, the designers reported that the park is a gathering space for 'parkour' and 'boules' groups, although we did not observe these activities during the site observations. The diverse range of activities afforded in the park indicates that it promotes a healthy lifestyle for users, and thus supports aspects of social sustainability.

Additionally, community members were able to have a voice in the design and planning process for the park, which suggests social sustainability. Two interviewees specifically referred to the high level of community involvement amongst the neighbourhood residents. James (*2014*) associated this with the strong history of community involvement in the neighbourhood.

However, other details, such as the relative affluence of the surrounding neighbourhood, the lack of economic and ethnic diversity of the residents (*ABS 2014*), and the missed opportunities for environmental education suggest the social sustainability of the park is mixed. For example, one interviewee raises the possibility of exclusivity, stating, ‘I would always argue that open space is for everyone. I think everyone who lives in a particular area always feels a certain ownership of the neighbourhood. But you know open space should never be exclusive’ (*Kennedy 2014*). Although it was not the intention, the involvement of predominately local residents during the community consultation process impacted the park’s regional use, creating inequity.

In addition to equity, we focused on the social acceptance of green innovation by investigating the ‘knowledge’ of the intended audience (*Assefa and Frostell 2007: 69*) and ‘interpretation’ of the specific intervention (*Rogers et al. 2012: 95*). We found a clear intent to communicate sustainability through the design. For example, the principle designer emphasized that the design signals a shift in thinking about energy, ‘the biggest fossil fuel tank turned into the biggest wind turbine on Sydney Harbour. There is poetry there’ (*Coxall 2014*). In addition, one interviewee who worked on the research, design development, and application of renewable energy devices for the project (*McDermott 2014*) discussed the choice of wind turbines over solar panels and indicated that solar panels lacked the aesthetic qualities of wind turbines and generally hid the message of sustainability for the purposes of promotion and education. Yet, despite the brilliant initial message that was intended, we found a missed opportunity to effectively interpret the energy story of the site into a complete user experience for local and regional users.

Through our user survey, we found that only 24 percent of the park users, primarily local users, knew that the site could potentially generate electricity [Fig. 8]. In addition, none of the regional users noted or understood the wind turbines and many actually misunderstand their purpose on the site. For example, one park user thought the turbines were for mobile phone reception.

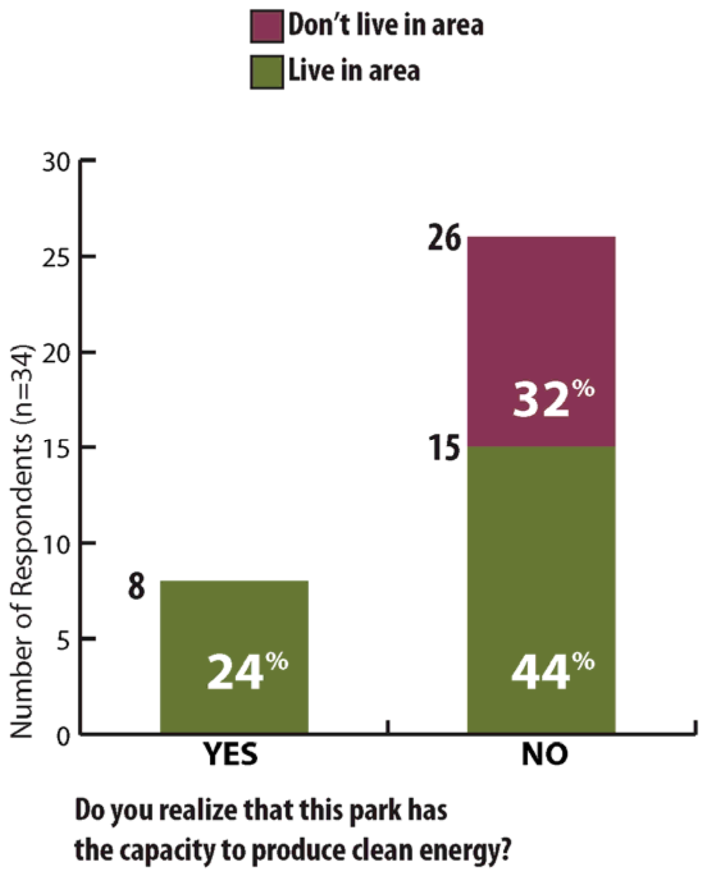

Figure 8 Survey demonstrates the response of local and regional users to renewable energy use in the park

In the next section, we discuss the environmental sustainability of the design.

Environmental

Through this research, we found that the park generally meets environmental sustainability objectives, including but not limited to, balancing microclimate factors of the urban heat island effect, increasing urban biodiversity, and using storm water bio-filtration. However, as stated earlier, this paper is primarily concerned with renewable energy as it is embedded into public spaces. Therefore, we have analyzed the environmental sustainability aspects of Ballast Point Park using a narrow definition that focuses privileges renewable energy.

According to designers, experts, and critiques, environmental sustainability was the main focus for the design of Ballast Point Park and the intention of using renewable energy as an innovative approach to environmental sustainability was well received by multiple stakeholders, including the public. However, from our site observations and interviews, our research discovered that the wind turbines designed to provide electricity for the park, do not currently function as originally planned. Since the opening of the park in 2009, the park has never produced electricity and there is no record of electricity production that feeds the grid or contributes to the operation of the park.

During our site observations, we discovered that the northern winds were dominant on the site due to the exposed promontory along the Parramatta channel and Sydney Harbour. Using an anemometer to record the wind strength at six observation zones, and the location of the original wind turbines for two weeks, we recorded up to 60 km / h wind values around the park. The average wind speed for each day ranged from 2.1 to 19.7 km / h. We measured an average speed of 5.5 km / h about 6 m below the location of the existing wind turbines. [3] Our data showed that the location of the wind turbines did not align with the zones exhibiting the highest wind speeds [Fig. 9]. [4]

AVERAGE WIND VALUES (km/h)							
Date	Zone1	Zone2	Zone 3	Zone 4	Zone 5	Zone 6	Wind Turbines location
DAY 1	19.7	7.1	5.6	8.5	9.6	9.8	7.1
DAY 2	6	7.6	6.9	4.8	7.4	6.5	6.4
DAY 3	19.3	8.4	10.8	9.7	12.7	11.2	11
DAY 4	7.4	8	8.6	4.9	3	7.1	5.2
DAY 5	3.9	4.9	3.5	3.4	3.9	3.8	2.1
DAY 6	9.5	6.7	7.8	6.7	6.3	6.8	2.1
DAY 7	10.4	6.7	14.1	8.1	5.9	10.4	4.3
Average	10.9	7	8.2	6.6	7	8	5.5

Zones were visited several times on each day and the daily average wind speed was calculated from the results. We then calculated an average wind speed over one week.

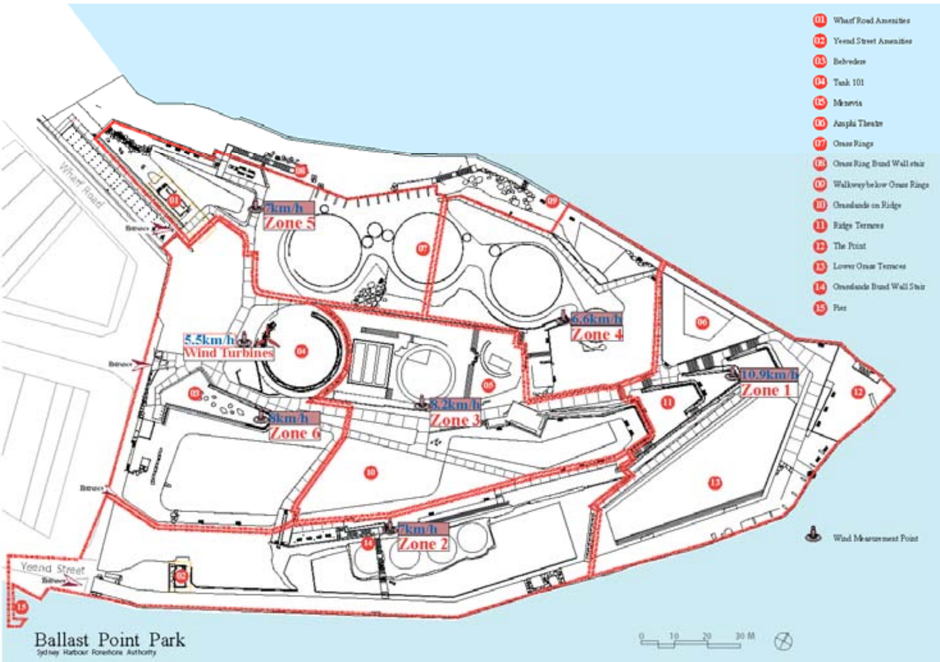

Figure 9 Drawing shows existing functions of the park, observation zones and locations. Base map is the courtesy of McGregor Coxall.

These observations were supported through our interviews revealing that yearly wind data was not used during the design phase to locate the wind turbines in the best location for the best possible yield. There were no calculations completed, but only estimates based on the specifications of the turbines. Therefore, we found that the choice of reusing the Tank 101 as the location for the wind turbines was misguided by a desire to reuse a historic structure and create a functional art piece in the park.

Conclusion / discussion

This paper addresses the need to determine if public spaces meet acceptable standards of sustainability. Focusing on renewable energy distribution within public space, we used a case study method at Ballast Point Park to explore TBL as a framework for design. Specifically, our findings show that in order to design truly sustainable environments, designers of public spaces need to consider all three TBL components, and particularly need to consider how to achieve economic sustainability in addition to social and environmental sustainability.

Our findings indicate that although Ballast Point Park is a successful, well-designed park on many different fronts, it does not yet reach its true potential according to the TBL framework. Ballast Point Park lacks sustainable services and goods production in order to accomplish economic sustainability. In addition, despite its internal and local social cohesion, equity is problematic due to a lack of regional use and accessibility, thus limiting social sustainability. Consequently, the environmental sustainability, which depends on the other two TBL components, is not sufficiently accomplished. More specifically, using a TBL framework, we determined:

Economic

- Ballast Point Park was funded as a state asset that was subsidized by all taxpayers and was designed as a regional park. Yet, it currently functions as a local park for predominately local users, which may not justify the funding outputs.
- The wind turbines located within the historic structure do not function as originally intended and, therefore, do not reduce park maintenance costs.

Social

- Regional use is crucial for long-term social sustainability of the park in order to create true equity within the Sydney context, making the park's strong historic and environmental character, as well as recreational amenities accessible to everyone. However, a lack of programming and public space management limits the regional use.
- The social acceptance of renewable energy use is problematic in Ballast Point Park. Local residents agreed upon having renewable energy in the park during community consultation process. The promotion and advertisements for this award-winning project rely on the assumption of the active electricity production on site. Despite this, or perhaps because of this, people using the park expressed limited knowledge of the potential electricity production from wind turbines. Therefore, the project does not effectively interpret the energy story of the site and misses an opportunity to create a complete user experience for local and regional users.

Environmental

- Although the park responds to other environmental sustainability objectives successfully, the environmental pillar with regard to renewable energy is problematic since the wind turbines currently do not function.
- Because environmental sustainability relies on the other two components to be successful, the design has yet to satisfy true environmental sustainability.

Recommendations

With an increased need for renewable energy usage in public spaces, we propose a model for designers to incorporate electricity production from renewables as a design feature. Ballast Point Park, with its unique and controversial history, together with multi-award winning environmental quality, can better meet the TBL objectives by reinventing the renewable energy usage on site. Fortunately, the designers and experts indicated that there is a plan in place to fix the malfunctioned wind turbines.

In addition, implementing public space management and place-making strategies into electricity production from renewables can attract a diverse range of local and regional users. Considering the sporadic regional events occurring in the park, such as marriages and birthday celebrations, a huge potential exists to facilitate events focused primarily on sustainability. As the managing authority to organize events in other Sydney Harbour venues, SHFA can introduce and manage green events in the park run by on-site renewable energy. In doing so, it would increase regional use as well as create an economy to self-sustain the park and its community in both the short- and long-term. These suggested interventions would supplement the park's environmental functionality, instigate social and economic momentum, and address the park's reputation promoted through advertisements about electricity production from renewables. In addition, direct electricity uses such as charging points for mobile devices, playful interactive energy toys, and artistic interpretive energy screens can be used to support both local and regional use and could impact the social acceptance of renewable energy by increasing knowledge and establish a communication between designer and user, and also bridge physical, social, and environmental aspects of the designed public space. Public space is essentially a social space where renewable energy can be used not just for production, but to change people's understanding and acceptance of renewable energy, and thus change their actions.

On the basis of our findings, we propose a potential design framework for electricity production, consumption, and distribution of renewable sources embedded in the public open spaces. [5] Ingrained in Howard Odum's (*1976*; *2007*) energy concept of ecosystems, and the objectives of TBL (*Rostami et al. 2014*) that indicates the environmental function is only achievable when the other two are in line, we devised the following diagram [Fig. 10]. The diagram conceptualizes an optimal distribution of electricity produced from renewable sources in public open spaces. Although it is beyond the scope of this paper to fully test this potential framework, it begins to 'decouple' the activity of production from the concept of renewable energy devices, in and around public spaces.

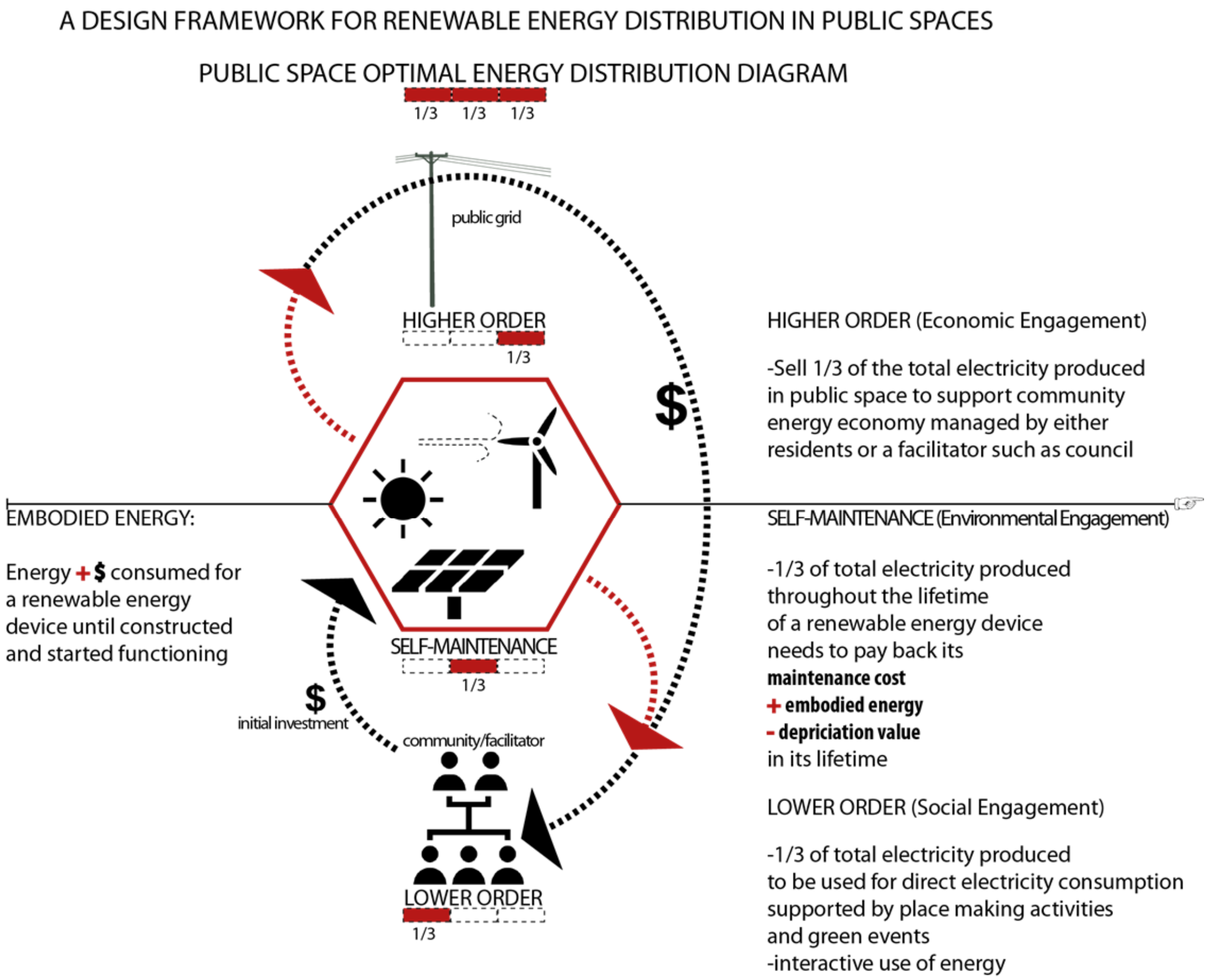

Figure 10 Optimal electricity distribution diagram: Design framework for renewable energy in public open spaces

To equally distribute the produced electricity in public space, we have determined three levels of need based on ecological principles. One-third of electricity produced in the public space will contribute to ‘economic engagement’ (higher order). It will be sold to the public grid and utilized to support community renewable energy economy managed by either local residents or a facilitator, such as council. The initial investment cost will be either subsidized by the community or the facilitator (for example, SHFA).

One-third of the electricity produced will be utilized for ‘self-maintenance’, which refers to ‘environmental engagement’. This means one-third of the total electricity produced throughout the life of a renewable energy device ideally needs to pay back its maintenance cost and embodied energy. [6] The depreciation value of any renewable energy device in its lifetime can be calculated based on existing data and subtracted from the production value. In addition, considering the decreasing cost of these technologies, the device may recoup the cost with one-third of its electricity production. This part of the equation includes the daily electricity demands of public space including lighting, as well as any possible energy storage facility. [7] Once the capacity of renewables increase in time, the surplus energy can either be sold to the grid or stored to be used for direct and indirect use within public space context.

The last one-third of the electricity produced in public space is designated for ‘social engagement’ (lower order usage). This is to be used for on-site direct electricity consumption supported by place-making activities and green events. The ‘lower order usage’ also includes interactive, performance-based, as well as indirect electricity usage incorporated into artistic approaches to increase public engagement. This requires extra attention from the designers of public space, as interpretation and sense of place need to be considered.

Over the last decade, renewable energy use within an urban context has often been considered as a retrofit and appears as an addition or technological fix to public space designs. As a framework, the TBL helped us to investigate this issue in Ballast Point Park in Sydney. We believe changing the understanding of renewable energy from a technological fix to a communal production activity identified new potential relationships in and around a public space, not only for community but also for designers of public open spaces. Yet, a sustainable energy transition requires bottom up approaches as much as it requires top down policies. With the increasing number of production activities in cities, public spaces offer great opportunities to convey the idea of renewable energy and to educate people to accelerate the sustainable energy transition. By using TBL as a framework for public open space design, we can begin to take a more balanced approach to sustainability and ensure that the social and economic components contribute to the overall design. Thus, improving the sustainability of public open space design.

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Notes

1 'The commons is a way of thinking and operating in the world, a way of organizing social relations and resources'(*Eizenberg 2012: 764*). He further describes 'existing commons should not be seen as a "return" of some noble but possibly archaic ideal but as a springboard for critiquing contemporary social relations and as the production of new spatiality, initiating the transformation of some fundamental aspects of everyday life, social practices and organization, and thinking'(*Eizenberg 2012: 779-80*).

2 This study is approved by the Queensland University of Technology Human Research Ethics Committee (*no: 1300000817*).

3 While taking the spot measurements, our limitation was the height of the anemometer which stood on a tripod 1.75 m above the ground.

4 General specifications of 8 x 1 kW vertical axis turbines recommends a minimum starter speed (cut-in speed) about 10 km / h, and generates maximum 750 W, when the wind blows at 50 km / h.

5 This paper is a component of Kaan Ozgun's PhD research about renewable energy distribution in public open spaces. The recommended design framework in this paper is further advanced and will be published in the near future.

6 For example, energy pay back times of Photovoltaic is one to seven years depending on the module technology (*Alsema and Fthenakis 2006*). Another research's finding concerning energy pay back times of solar, geothermal, wind wave, and tidal power is an average of three years (*Roberts 1980*).

7 According to Odum, it is good to have a large amount of production as long as the storage is available with more interaction. He states, ‘With increasing scale of available energy (the production capacity of renewable energy in public space), storages increase, depreciation decreases and pulses are stronger but less frequent’ (*Howard T. Odum 2007: 63*). This definition depicts the behaviour of mature complex ecosystems and has been applied to national policies under the name ‘sustainability’ (*Ibid: 54*). From a public space point of view, a higher amount of electricity production from renewables means that more social interaction and storage will be required to use produced electricity sustainably.

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